OESI Power Corporation

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91 JUN 13 A10: 34

DIV. OF WATER & LAND DEVELOPMENT

June 7, 1991

Mr. Norman Hayashi
Planning Director
Hawaii County Planning Department
25 Aupuni Street
Hilo, HI 96720

Subj: VENTING/TESTING KS-8

Dear Mr. Hayashi,

Puna Geothermal Venture (PGV) is currently drilling well KS-8 located on wellpad D alternate. As we have discussed previously, PGV is currently planning on doing a 28 rig-test. This rig test will involve the venting of the well for a maximum of four hours prior to the transferring of flow to the test skid located on wellpad E. During the actual 24 hour flow-testing all operations will be as was performed on KS-3 in March; however we are going to abate this four hour fluid steam by injection of sodium hydroxide into the horizontal muffler that will discharge to our KS-8 reserve pit. For your reference and detail I have attached a copy of a letter sent to the Department of Health (DOH) in regard to the chemical treatment plan that addresses the plan and layout.

The planned date of this venting is on or after June 17, 1991; and this date is subject to the well completion and drilling activities. We intend to send notifications to all required agencies and administrations and the residents on or after June 13, 1991, as at that time we will know much better as to what the actual date will be.

Please review this letter and if you or your staff have any questions, please do not hesitate to contact me.

Sincerely,

Norman J. Clark
Project Manager

Attachment:

NC/kk

cc: Distribution List Attached:
T. Kizis, B. Teplow, File: 7.13.3, 1.2 (20794F/kk)

PUNA GEOTHERMAL VENTURE

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778
Post Office Box 1337, Hilo, Hawaii 96721-1337

(808) 961-2786
Facsimile (808) 935-5562

ORMAT®

June 5, 1991

John C. Lewin, M.D.
Director of Health
State Department of Health
P.O. Box 3378
Honolulu, HI 96801

Re: CHEMICAL TREATMENT PLAN

Dear Dr. Lewin,

Puna Geothermal Venture is planning to run a 24-hour rig test of well KS-8 which is currently being drilled (Figure 1). This rig test will consist of flowing KS-8 with the drill rig on the well. The test will take place on or shortly after June 24, 1991. The rig test program (Attachment A) is attached for your review.

The Pursuant to Condition No. 18 of the Authority to Construct No. A-833-795 for Puna Geothermal Venture (PGV), PGV is required to submit a chemical treatment plan for abatement of H2S during flow testing. The chemical treatment plan used for the flow testing of KS-3 will be used for the KS-8 rig test and will be implemented using the same test facility (Figure 2). A copy of that program is attached (Attachment B). The treatment plan for KS-3, which was reviewed by your staff, proved to be highly effective in maintaining H2S emmission levels well below permit limits.

Some additional equipment and procedures will be required for the KS-8 rig test that were not used on the KS-3 test. These modifications to the test program are as follows:

1. The initial water- and particulate-rich slug will be discharged through a horizontal muffler to the KS-8 reserve pit located on Pad D. This flow will be abated using caustic injection at the muffler inlet (Figure 3). This phase will last no more than 4 hours.

2. After the initial blowdown is completed, the steam/brine mixture will be transferred to the test facility and abatement unit on Pad E via a 10" pipeline (Figure 1). For the duration of the test the test procedure and abatement process will be identical to that used in the KS-3 flow test.

3. During both of the above testing phases, PGV will periodically monitor H2S levels at the property boundary directly down wind from the steam discharge. The monitoring will be performed with a Jerome 631-X portable hydrogen sulfide analyzer with a detection limit of one (1) part per billion (ppb).

PUNA GEOTHERMAL VENTURE CONSTRUCTION

P.O. Box 1337 • Hilo, Hawaii 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

If you have any questions regarding the proposed program, please give me a call.

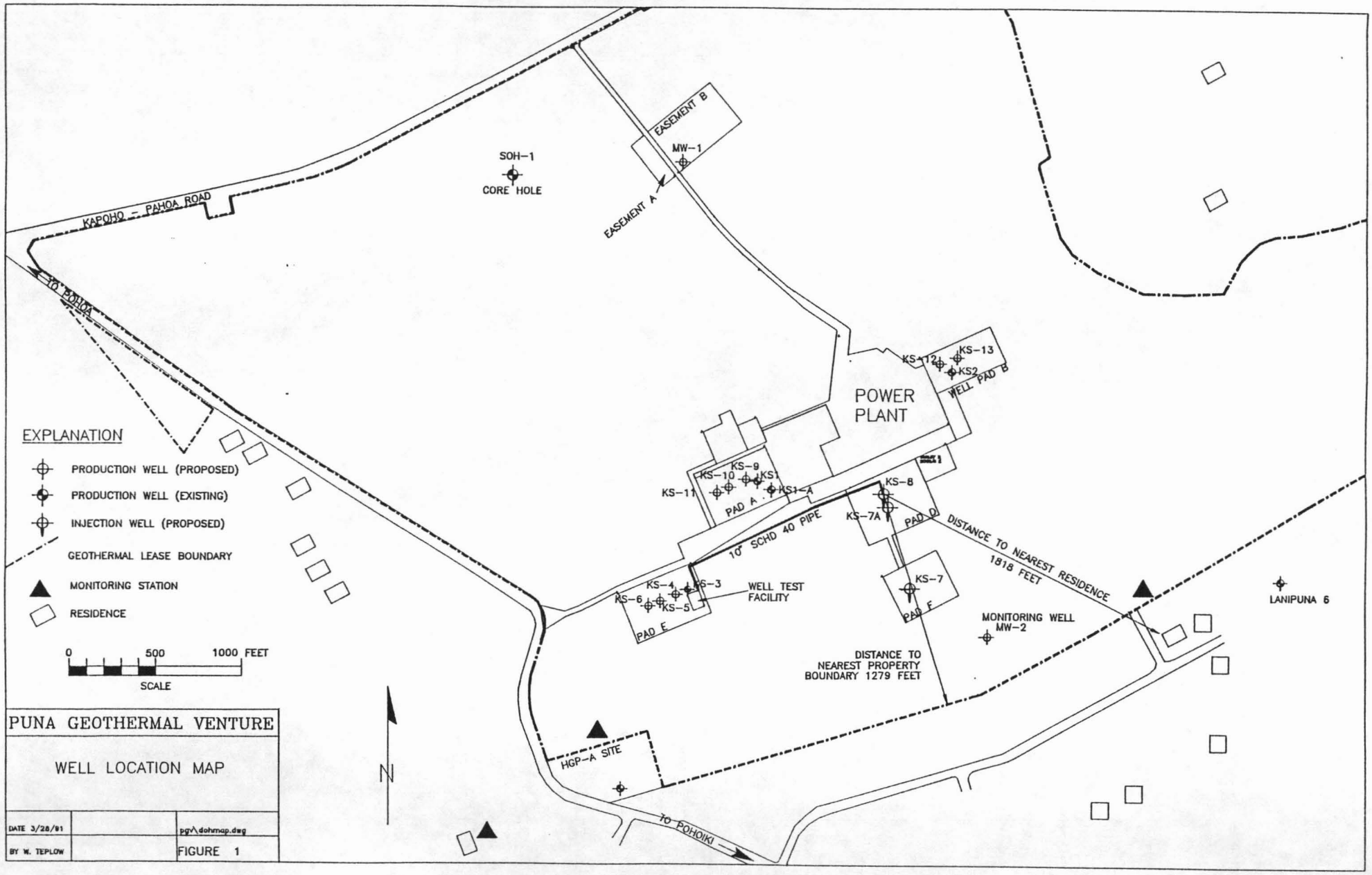
Sincerely,
Puna Geothermal Venture

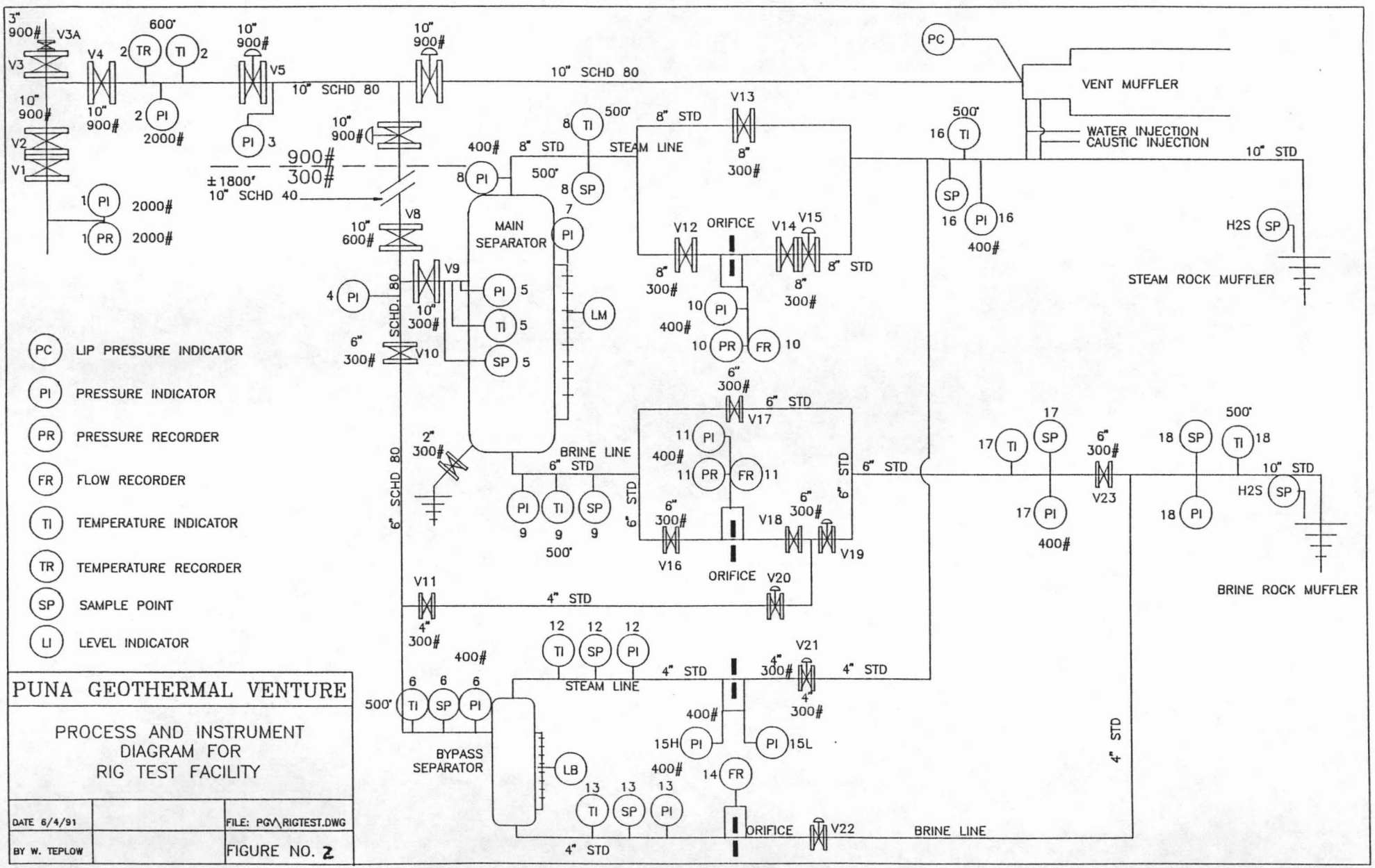
William Teplow
Field Manager

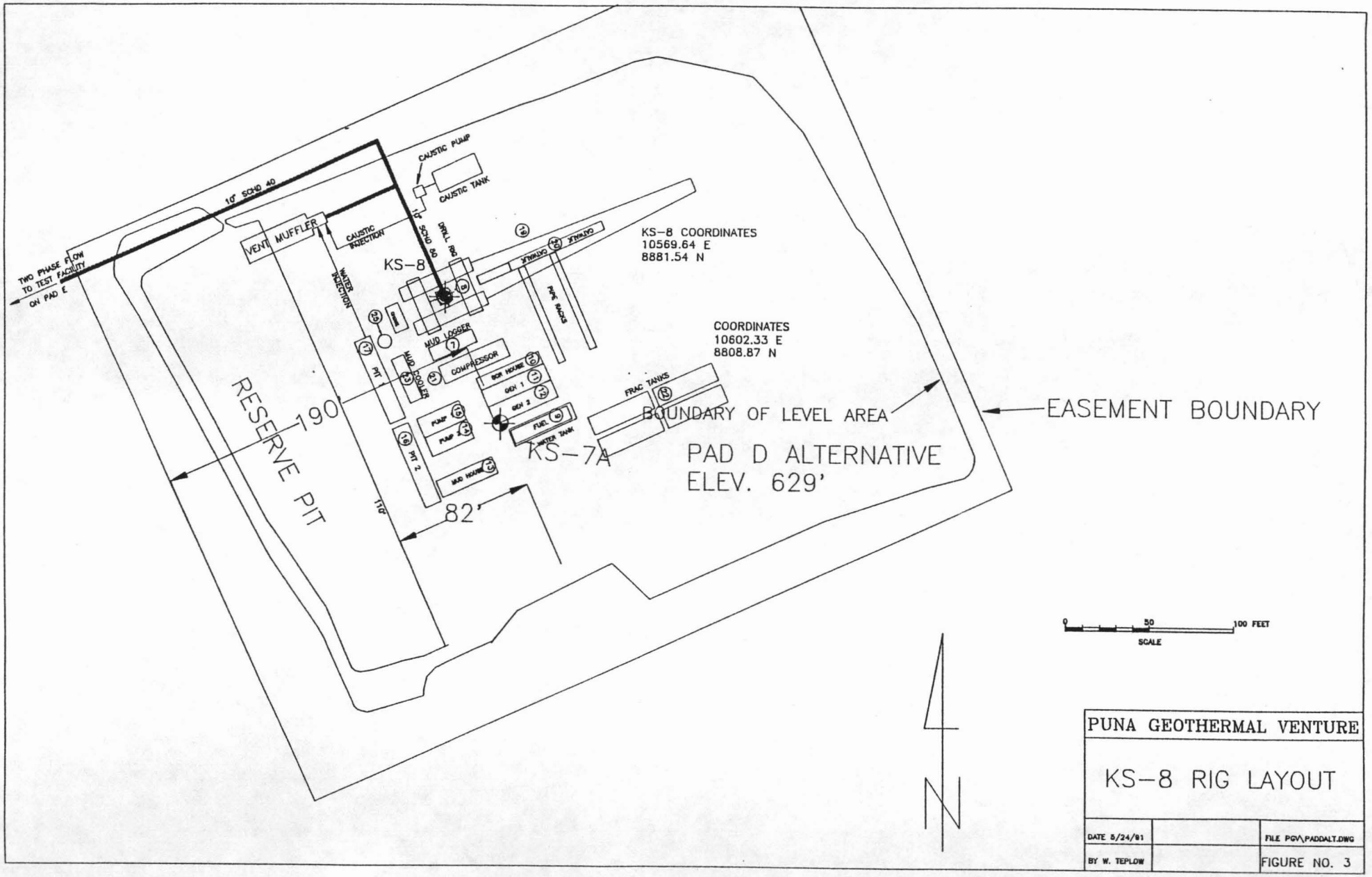
cc: Nolan Hirai (DOH)
Chauncey Hew (DOH)
Dean Nakano (DLNR)
Rodney Nakano (CPD)
N. Clark
T. Kizis
File (14.2.18 - Cond. 18)

Attachments:

Doc: 20454F


KAPOHO – PAHOA ROAD
TO PAHOA
SOH–1
CORE HOLE
EASEMENT B
MW–1
EASEMENT A
POWER PLANT
KS–12
KS–13
KS2
WELL PAD B
KS–9
KS–10
KS1
KS–11
KS1–A
PAD A
KS–8
KS–7A
PAD D
10" SCHD 40 PIPE
DISTANCE TO NEAREST RESIDENCE 1818 FEET
KS–4
KS–3
KS–6
KS–5
WELL TEST FACILITY
PAD E
KS–7
PAD F
MONITORING WELL MW–2
LANIPUNA 6
DISTANCE TO NEAREST PROPERTY BOUNDARY 1279 FEET
HGP–A SITE
TO POHOIKI
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
N
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
DATE 3/28/91
pgv\dohmap.dwg
BY W. TEPLOW
FIGURE 1


PC LIP PRESSURE INDICATOR
PI PRESSURE INDICATOR
PR PRESSURE RECORDER
FR FLOW RECORDER
TI TEMPERATURE INDICATOR
TR TEMPERATURE RECORDER
SP SAMPLE POINT
LI LEVEL INDICATOR
VENT MUFFLER
WATER INJECTION
CAUSTIC INJECTION
STEAM ROCK MUFFLER
BRINE ROCK MUFFLER
MAIN SEPARATOR
BYPASS SEPARATOR
STEAM LINE
BRINE LINE
ORIFICE
10" SCHD 80
6" SCHD 80
10" SCHD 40
±1800'
900#
300#
PUNA GEOTHERMAL VENTURE
PROCESS AND INSTRUMENT DIAGRAM FOR RIG TEST FACILITY
DATE 6/4/91
BY W. TEPLOW
FILE: PGV\RIGTEST.DWG
FIGURE NO. 2



PUNA GEOTHERMAL VENTURE

KS-8 RIG LAYOUT

DATE 5/24/91		FILE PGV\PADDALT.DWG
BY W. TEPLOW		FIGURE NO. 3

H_2S ABATEMENT PERFORMANCE PLAN

I. INTRODUCTION

During testing, geothermal fluid flows through a separator where it is divided into two phases, brine and steam. Each phase then passes through a meter run for mass flow measurement or optionally, through a meter run bypass loop. Finally, the brine and steam discharge into different rock mufflers.

When the geothermal fluid flashes and separates into two phases, the non-condensable gases, including H_2S, are concentrated in the vapor phase. The abatement system, therefore, operates on the steam fraction of the total discharge.

H_2S is removed by injecting an aqueous solution of sodium hydroxide into the steam.

II. STEAM SAMPLING

To measure the H_2S concentration of steam emitted to the atmosphere, steam samples are taken directly from the rock muffler.
A stainless steel sampling tube is buried in the rock muffler a few feet from the surface. Steam is drawn by a vacuum pump from the rock muffler and analyzed according to the procedure described in section III.

To measure the H_2S concentration in the steam before treatment, steam samples are taken upstream of the orifice.

III. H_2S TESTING

There is no known method or instrument that can accurately measure the concentration of gases in saturated steam on a continuous basis. Instead, discrete samples of steam are withdrawn at regular intervals. The samples are then immediately analyzed for H_2S concentration using a proven analytical method. The test method employed is the Silver Nitrate Potentiometric Determination. (See appendix 1 for test procedure.)

To determine H_2S concentration, the steam sample is condensed and bubbled through a solution of sodium hydroxide. The H_2S is chemically trapped in the hydroxide solution. The sample bottle is weighed before and after the sampling procedure, allowing the precise weight of condensed steam to be determined. The weight of H_2S in the sample is determined by a chemical titration. Silver nitrate of a known concentration is slowly added to the sample. The silver nitrate removes H_2S from the solution by reacting with

it to form an insoluble salt. An electrode placed in the solution alerts the technician when excess silver ions are present, indicating that all of the H_2S has been removed. Since the reaction between silver ions and H_2S is well understood, the amount of silver nitrate used during the titration can be related to the amount of H_2S removed. The ratio of H_2S to total sample is equal to the concentration of H_2S in the steam.

IV. H_2S ABATEMENT

H_2S is removed from the steam by adding an aqueous solution of sodium hydroxide. The reaction is as follows:

$$H_2S + NaOH <-> NaHS + H_2O$$
$$H_2S + 2NaOH <-> Na_2S + 2H_2O$$

The sodium hydroxide solution is injected into the flow line using chemical metering pumps, which allow the operator to precisely control the injection rate.

The reaction only takes place in the presence of water. Between 50 and 200 gallons of water per minute will be injected into the flow line along with the sodium hydroxide.

H_2S compliance is verified by determining the mass flow rate of H_2S into the atmosphere. This flow rate is the product of the steam mass flow rate and the H_2S concentration:

$$H_2S \text{ (lb/hr)} = \text{Steam (lb/hr)} \times H_2S \text{ (concentration)}$$

The steam flow rate is being measured continuously during the test using a critical flow orifice. H_2S concentration is determined at regular intervals as described in section V.

V. ABATEMENT PROCEDURE

1.0 Estimate what the steam flow rate and H_2S concentration in the steam will be at the beginning of the test. Based on this estimate, calculate the sodium hydroxide injection rate at a 4:1 mole ratio.

2.0 When the test starts, begin injecting sodium hydroxide immediately based on the estimate. Also, begin water injection immediately.

3.0 Perform an after-treatment H_2S concentration test, calculate steam mass flow in pounds per hour, and calculate the emission rate of H_2S in pounds per hour.

4.0 If emissions are out of compliance, increase injection of sodium hydroxide.

5.0 Immediately withdraw another steam sample and analyze for H_2S.

6.0 Continue this cycle of adjust-then-retest until emissions are in compliance.

7.0 Sampling frequency

a. Follow procedure items 3 through 6 each hour after the beginning of each steam flow test until two successive steam flow measurements are within ten percent of one another.

b. When two successive steam flow measurements are within ten percent of one another, follow procedure items 3 through 6 four times per day at regular intervals. Additional tests will be made when significant changes in the resource occur.

8.0 Record keeping

a. Records will be written in ink, using a permanently bound notebook. All pages will be numbered.

b. An entry will be made into the record book documenting each H_2S test that demonstrates compliance has been met. These tests will be numbered sequentially. No fewer than four entries per day will be made. Additional entries will be made when significant changes in the resource occur.

c. Data in the record book will include:

- Date
- Time
- Steam flow rate (pounds per hour)
- H_2S concentration (ppm) upstream and downstream of chemical injection
- H_2S concentration (ppm) and flow rate (pounds per hour) downstream of chemical injection
- Sodium hydroxide injection rate
- Sodium hydroxide storage volume on location
- A check box to acknowledge that the H_2S detector has been checked for zero and span
- comments and operators initials

Appendex A
TOTAL SULFIDE DETERMINATION

USING THE SILVER ELECTRODE POTENTIOMETRIC METHOD

INTRODUCTION

This method of sulfide determination absorbs the H2S in the steam condensate into an aqueous sodium hydroxide solution. Silver Nitrate is then used as a titrant to precipitate the sulfide ion as Ag2S. The end point is readily determined by the sharp potential shift due to excess silver ion in the solution after all of the sulfide has precipitated. Silver ion concentration is measured using an ion specific electrode.

PROCEDURE

A. Sampling

1. Weigh dry gas wash bottle (A).
2. Add approximately 50 ml NaOH to completely submerge the gas bubbler tip and weigh the bottle again (B).
3. Collect approximately 80 ml condensate and weigh the bottle again (C).

B. Titration

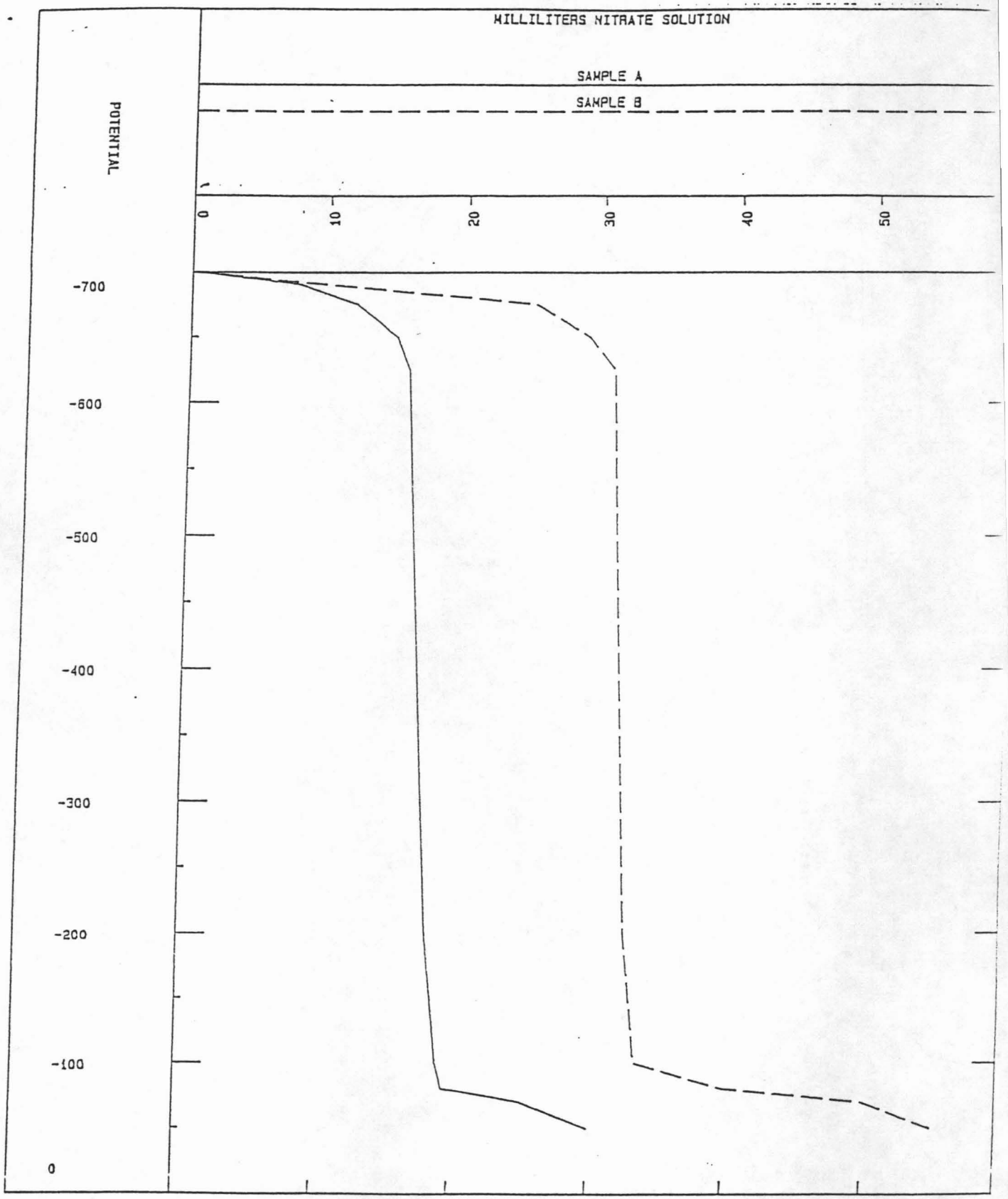
1. Weigh a dry 150 ml beaker.
2. Add approximately 50 ml of sample and weigh the beaker again.
3. Dilute the sample with approximately 50 ml distilled water.
4. Record the initial buret reading.
5. Titrate the sample using the AgNO3 solution until the end point is reached.

Since the endpoint to this titration is a sharp potential change (see figure 1) it will be necessary to add the AgNO3 slowly (about 1 ml/min) until the potential rises slightly. After this rise in potential, record the potential readings after adding each 0.1 ml of AgNO3. Continue adding the AgNO3 until there is a sharp rise in the potential; this is the end point. It is good practice to go beyond the end point to observe the flat part of the curve (see figure 1).

6. Record the final buret reading.

REAGENTS

NaOH	7%
AgNO3	10 g/liter


MILLILITERS NITRATE SOLUTION
SAMPLE A
SAMPLE B
POTENTIAL
0
10
20
30
40
50
-700
-600
-500
-400
-300
-200
-100
0

EXLOG SMITH
GEOTHERMAL DIVISION

R.F. Smith
Corporation

P.O. Box 666
Cobb, California
95426

Telephone: 707-928-5772

HYDROGEN SULFIDE DETERMINATION

OPERATOR _____ FLOW RATE _____

Well NO. _____ ORIFICE SIZE _____

DATE/TIME _____ WELL PRESSURE _____

TECHNICIAN _____ WELL TEMPERATURE _____

REMARKS _____

I. SAMPLING

(A) Weight of gas wash bottle _____

(B) Weight of bottle + NH_4OH _____

(C) Weight of bottle, NH_4OH + sample taken _____

II. TITRATION

	Sample #1	Sample #2	Sample #3
Weight of beaker + sample			
Weight of beaker			
Weight of sample			
Final buret reading			
Initial buret reading			
Total $AgNO_3$ used			

III. POTENTIAL READINGS

Sample #1		Sample #2		Sample #3	
Buret Reading	Potential	Buret Reading	Potential	Buret Reading	Potential

DATA FOR H_2S DETERMINATION

CALCULATIONS:

$$H_2S\ (ppm_w) = \frac{\text{ml. } AgNO_3 \quad \frac{10^{-3}\text{ g. } H_2S}{1\text{ ml. } AgNO_3} \quad \frac{\text{Grams of Codensate + } NH_4OH}{\text{Grams of Condensate}} \quad \frac{10^6\ ppm_w}{1}}{\text{Grams of Titrated Sample}}$$

$$H_2S\ (ppm_w) = \frac{(\text{Volume } AgNO_3 \quad (10^3) \quad \frac{(C-A)}{(C-B)}}{\text{Weight of Sample Titrated}}$$

SAMPLE #1 H_2S = _____ = _____ (ppm_w)

SAMPLE #2 H_2S = _____ = _____ (ppm_w)

SAMPLE #3 H_2S = _____ = _____ (ppm_w)

Average H_2S = _____ (ppm_w)

MEMORANDUM

To: Bill Teplow

From: Roger Harrison

Date: May 23, 1991

Subj: KS-8 RIG TEST PROGRAM

****

1. Introduction

KS-8 will be flow-tested for 24 hours immediately after completion, before the rig is moved off the well. The principal objectives of the test are as follows:

a. Define the stable discharge flowrate and enthalpy at the design wellhead pressure (225 psig).

b. Define steam, gas and brine chemistry at stable discharge conditions.

2. Test facility

The same separator facility employed for the test of KS-3 will be used to test KS-8. A 10" line will be run approximately 1800 feet from KS-8 to the test separator on wellpad E. The assembly will include a 10" bypass line exhausting to a horizontal vent muffler. The purpose of the muffler is to reduce the velocity of the discharge as it exhausts to the atmosphere. This will permit the water and particulate fractions to separate from the steam and drain to the pit. The H2S will be abated during this period.

The test assembly is shown in the attached figures. The well will be initially vented through the bypass for 3 to 4 hours and then diverted to the separator for the remainder of the test.

(20746F/kk)

3. Test Procedure

3.1 After reaching TD, circulate and condition hole, trip out and log.

3.2 Run in hole, circulate out mud with fresh water.

3.3 Remove BOP, assemble permanent well head and flow-tee, and nipple up flowline (see attached figure).

3.4 Nipple-up air compressor to choke manifold. Pump water level down to shoe of casing and hold 6 hours.

3.5 Release air quickly. If well fails to start flowing, try air compression again. If well fails again, run 2 7/8" tubing to 2000 feet and hang in top of flow-tee with tubing hanger. Initiate flow by air lifting through tubing.

3.6 Discharge well through horizontal muffler to mud sump for 4 hours. Abate H2S during 4 hour venting period.

3.7 After 4 hours divert flow through 10" pipeline to separator. Maintain WHP at 225 psig and flow until discharge conditions stabilize. Record pressures, temperatures and flow rates half-hourly. Collect steam, gas and brine samples every 2 hours.

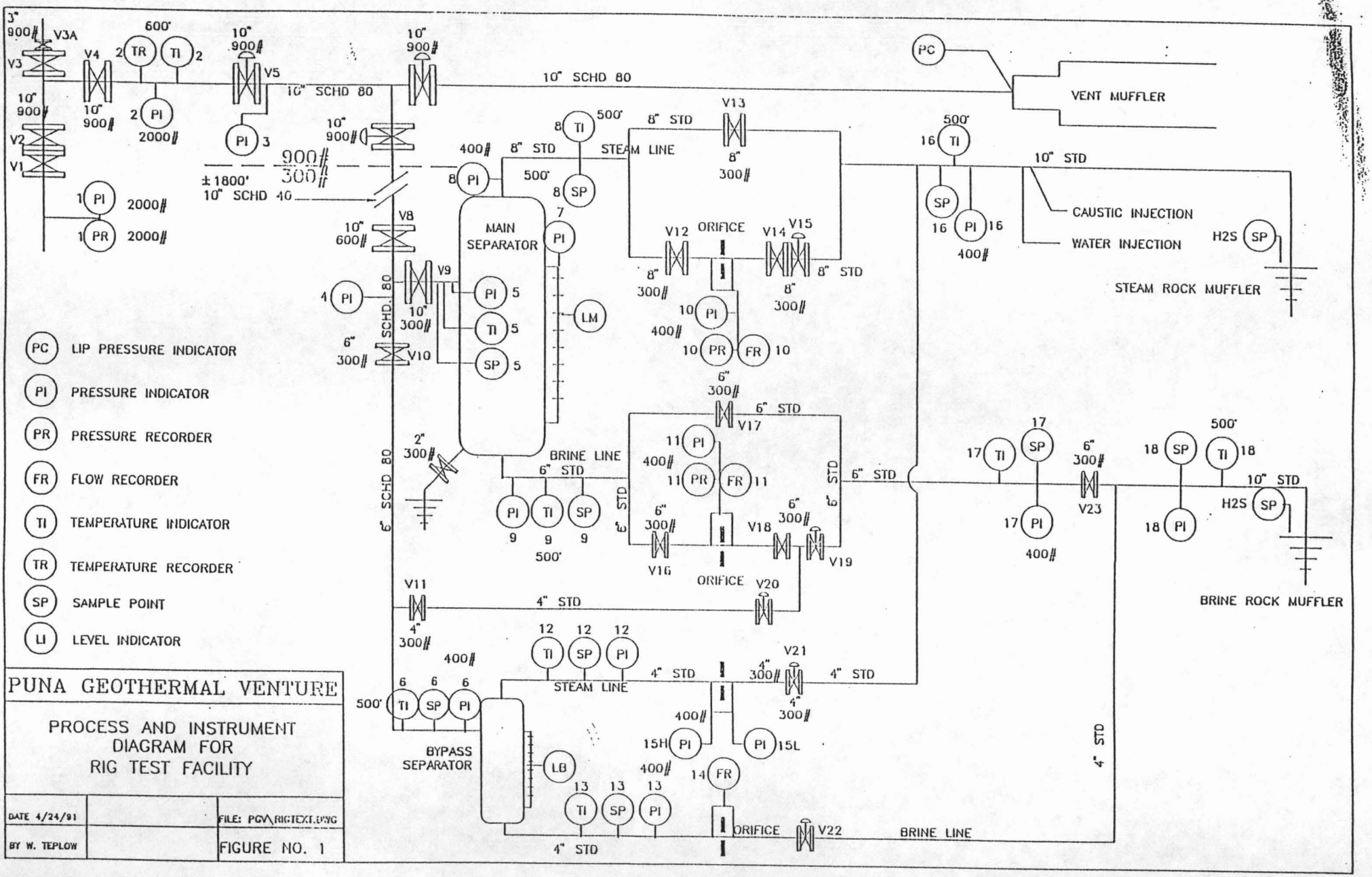
3.8 Run P/T survey when flowing conditions stabilize. Run to shoe of cemented casing if production interval is open-hole. Run to TD if slotted liner in-place.

3.9 If time permits, adjust wellhead pressure to obtain wellhead productivity curve. Attempt to obtain conditions at WHP=100 psig and 400 psig.

3.10 Return to WHP=225 psig and maintain until shut-in. Run P/T survey. Shut-in with instruments downhole. Wait 9 hours, retrieve instruments.

3.11 Conduct P/T survey to TD 2 days after shut-in.

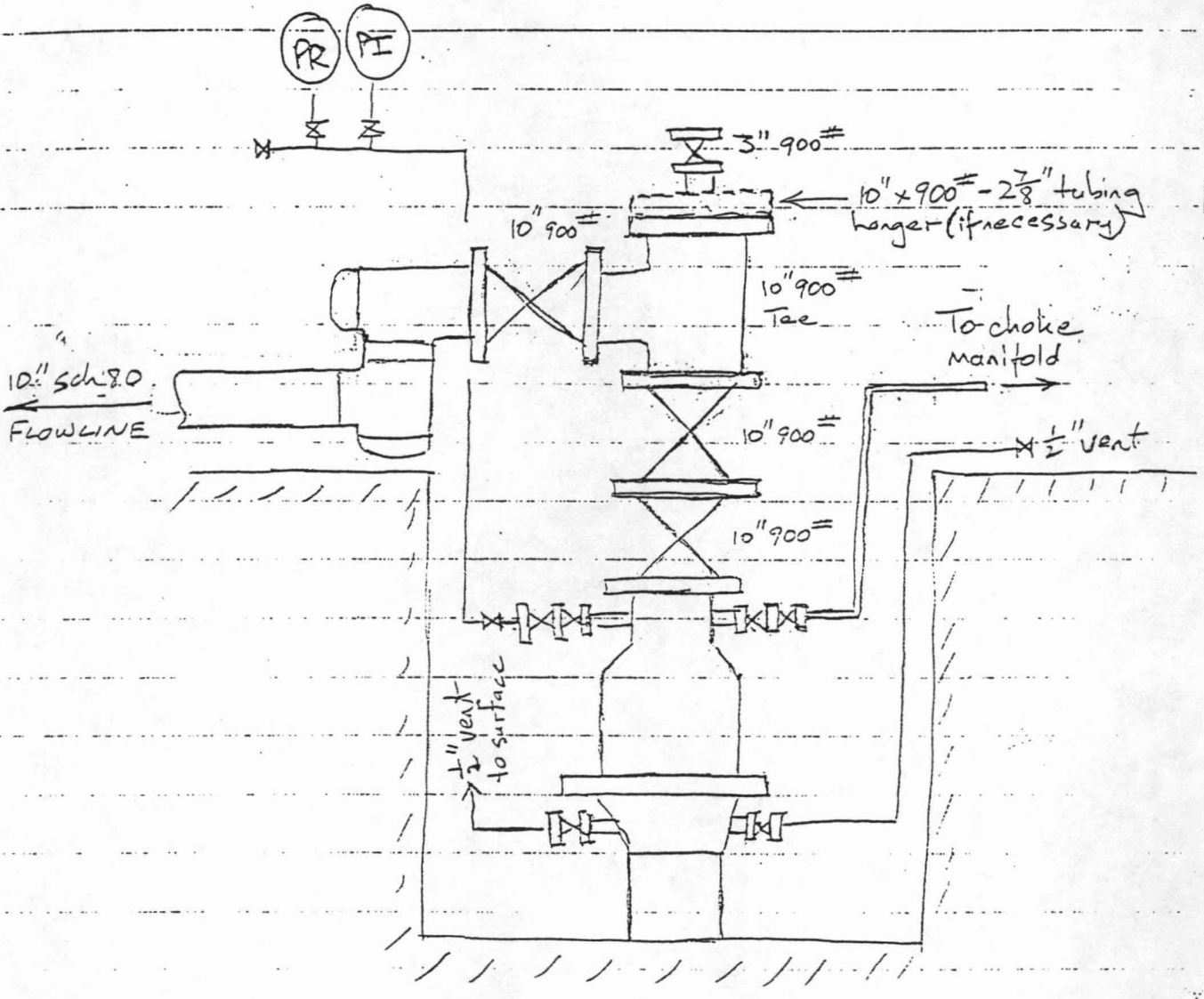
(20746F/kk)


PC LIP PRESSURE INDICATOR
PI PRESSURE INDICATOR
PR PRESSURE RECORDER
FR FLOW RECORDER
TI TEMPERATURE INDICATOR
TR TEMPERATURE RECORDER
SP SAMPLE POINT
LI LEVEL INDICATOR
MAIN SEPARATOR
BYPASS SEPARATOR
STEAM LINE
BRINE LINE
ORIFICE
VENT MUFFLER
CAUSTIC INJECTION
WATER INJECTION
STEAM ROCK MUFFLER
BRINE ROCK MUFFLER
10" SCHD 80
10" SCHD 40
6" SCHD 80
PUNA GEOTHERMAL VENTURE
PROCESS AND INSTRUMENT DIAGRAM FOR RIG TEST FACILITY
DATE 4/24/91
BY W. TEPLOW
FILE: PGV\RIGTEXT.DWG
FIGURE NO. 1

KS-8 Welltest

RFH
5/24/91

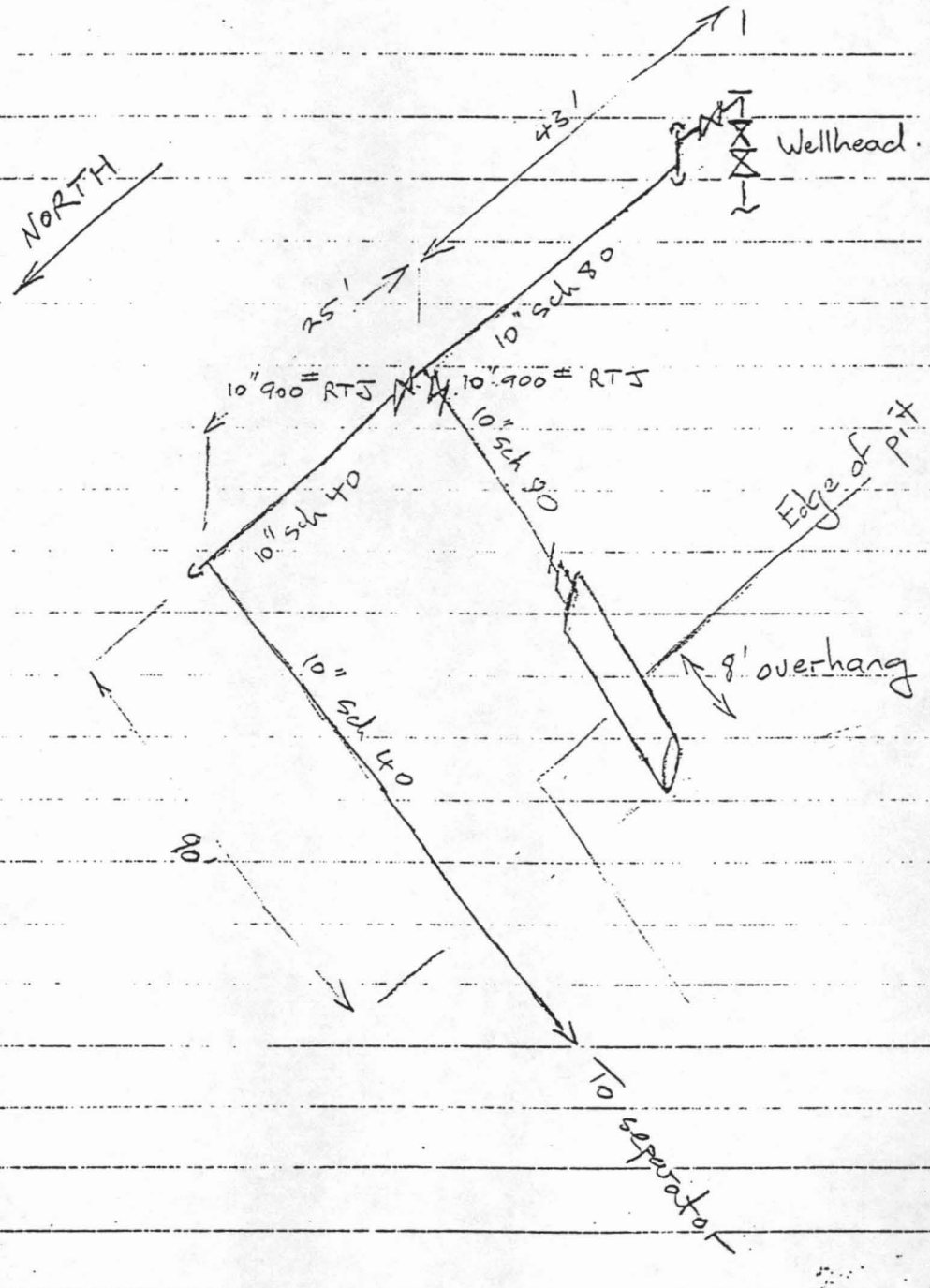
Wellhead Configuration



RFH
3/24/91

KS-8 Welltest

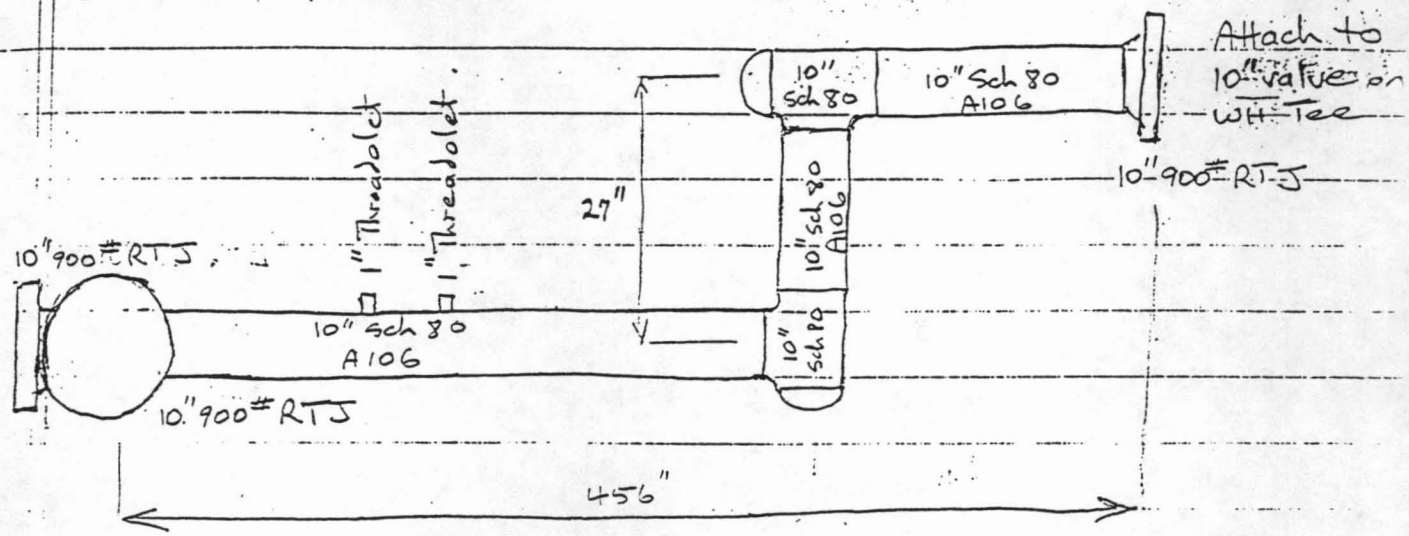
Wellpad Pipeline Layout



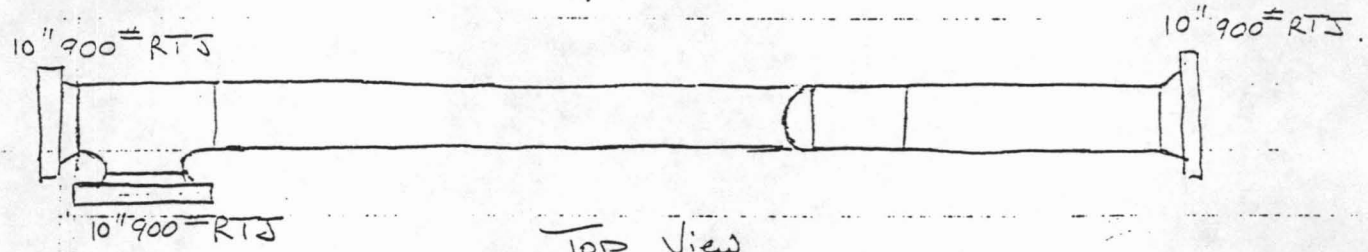
KS-8 Welltest

RFH
5/24/91

Wellhead Spool.

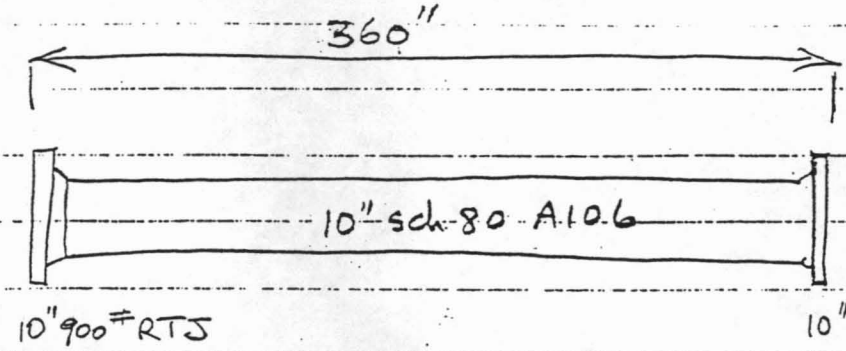


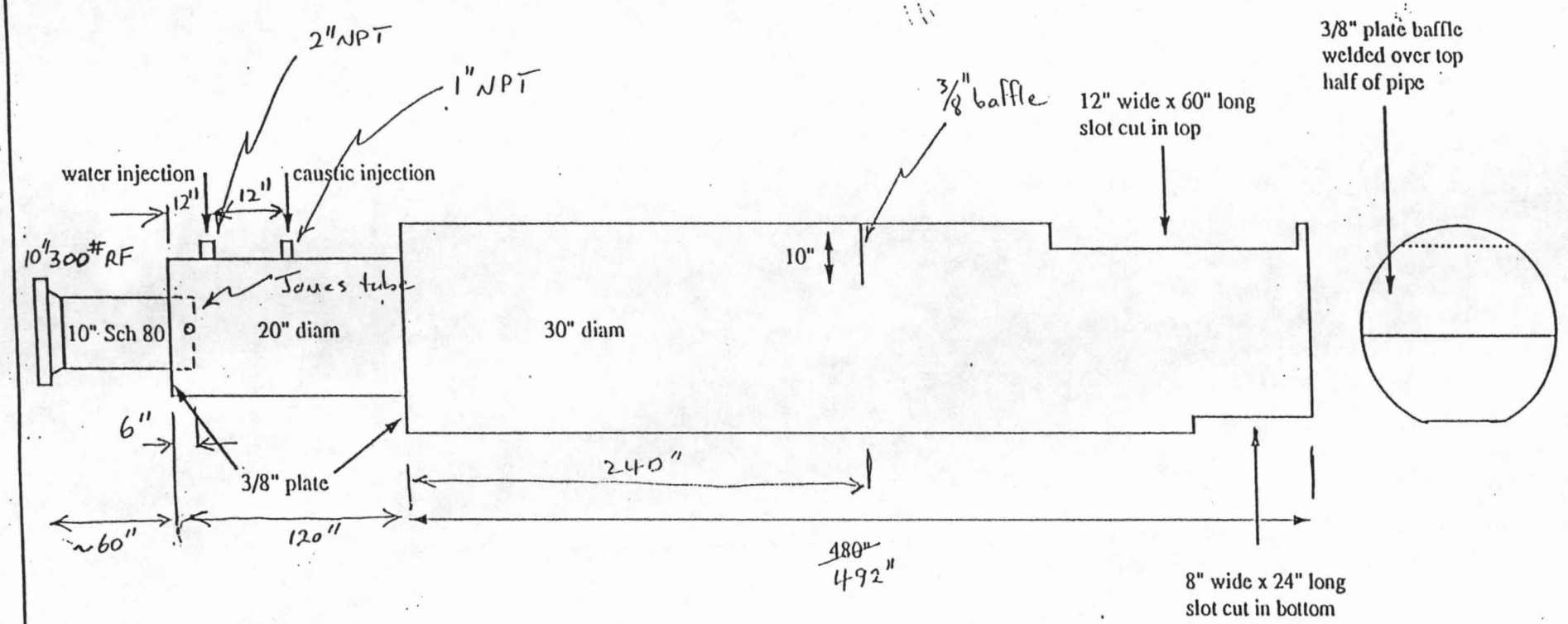
Side view



Top View

Vent Line Spool





Fabrication notes:

1) Construct from existing vent muffler - add 20' x 30" diam section
2) Remove existing swirl blades from end of 30" section
3) Add 3/8" x 10" deep baffle at mid point of 30" section as shown
4) Cut slots at end as shown
5) See separate sketch for Jones Tube Detail

Horizontal Vent Muffler	
RFH	5/24/91 5/18/91
Not to scale	

Mr. William Paty
Chairperson
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Deputy Director
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Mr. Dean Nakano

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Mr. Wilfred Nagamine
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